

What is claimed is:

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1 1. A reinforced composite ionic conductive polymer membrane  
2 comprising:  
3 a porous support;  
4 an ion-exchange polymer that impregnates the porous support; and  
5 a reinforcing agent that impregnates the porous support, the reinforcing agent  
6 being at least one selected from the group consisting of a moisture retentive material  
7 and a catalyst for facilitating oxidation of hydrogen.

1 2. The reinforced composite ionic conductive polymer membrane as  
2 claimed in claim 1, wherein the moisture retentive material comprises at least one  
3 selected from the group consisting of SiO<sub>2</sub>, TiO<sub>2</sub>, ZrO<sub>2</sub>, mordenite, tin oxide, and  
4 zeolite.  
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1 3. The reinforced composite ionic conductive polymer membrane as  
2 claimed in claim 1, wherein the catalyst comprises at least one selected from the  
3 group consisting platinum (Pt), palladium (Pd), ruthenium (Ru) rhodium (Rh), iridium  
4 (Ir), gold (Au), and a Pt/Ru alloy.  
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1           4.     The reinforced composite ionic conductive polymer membrane as  
2     claimed in claim 1, wherein the reinforcing agent comprises about 3-90% by weight  
3     of the moisture retentive material and about 10-97% by weight of the catalyst, based  
4     on the total weight of the reinforcing agent.

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1           5.     The reinforced composite ionic conductive polymer membrane as  
2     claimed in claim 1, wherein the ion-exchange polymer includes at least one selected  
3     from the group consisting of a sulfonic acid group, a carboxyl group, a phosphoric  
4     acid group and a perchloric acid group as a reactive site and has an equivalent  
5     weight of about 600-1200 g/H<sup>+</sup>.

1           6.     The reinforced composite ionic conductive polymer membrane as  
2     claimed in claim 1, wherein the porous support comprises at least one polymer  
3     membrane that has at least about 30% porosity.

1           7.     The reinforced composite ionic conductive polymer membrane as  
2     claimed in claim 1, wherein the porous support comprises at least one polymer  
3     membrane that is selected from the group consisting of polytetrafluoroethylene,  
4     vinylidene fluoride-hexafluoropropylene copolymer, polypropylene, polyethylene, and  
5     polysulfone.

1           8.     The reinforced composite ionic conductive polymer membrane as  
2     claimed in claim 1, wherein at least one functional group selected from the group  
3     consisting of a carboxyl group, a sulfonic acid group, a phosphoric acid group, and a  
4     perchloric acid group is incorporated into the polymer membrane.

1           9.     The reinforced composite ionic conductive polymer membrane as  
2     claimed in claim 1 which is formed by impregnating or spray-coating the porous  
3     support with a composition of the ion-exchange polymer and the reinforcing agent.

1           10.    A fuel cell comprising a reinforced composite ionic conductive polymer  
2     membrane, the membrane comprising:  
3         a porous support;  
4         an ion-exchange polymer that impregnates the porous support; and  
5         a reinforcing agent that impregnates the porous support, the reinforcing agent  
6     being at least one selected from the group consisting of a moisture retentive material  
7     and a catalyst for facilitating oxidation of hydrogen.

1           11.    The fuel cell as claimed in claim 10, wherein the moisture retentive  
2     material comprises at least one selected from the group consisting of  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  
3      $\text{ZrO}_2$ , mordenite, tin oxide, and zeolite.

1           12.    The fuel cell as claimed in claim 10, wherein the catalyst comprises at  
2   least one selected from the group consisting platinum (Pt), palladium (Pd), ruthenium  
3   (Ru) rhodium (Rh), iridium (Ir), gold (Au), and a Pt/Ru alloy.

1           13.    The fuel cell as claimed in claim 10, wherein the reinforcing agent  
2   comprises about 3-90% by weight of the moisture retentive material and about  
3   10-97% by weight of the catalyst, based on the total weight of the reinforcing agent.

1           14.    The fuel cell as claimed in claim 10, wherein the ion-exchange polymer  
2   includes at least one selected from the group consisting of a sulfonic acid group, a  
3   carboxyl group, a phosphoric acid group, and a perchloric acid group as a reactive  
4   site and has an equivalent weight of about 600-1200 g/H<sup>+</sup>.

1           15.    The fuel cell as claimed in claim 10, wherein the porous support  
2   comprises at least one polymer membrane that has at least about 30% porosity.

1           16.    The fuel cell as claimed in claim 10, wherein the porous support  
2   comprises at least one polymer membrane selected from the group consisting of  
3   polytetrafluoroethylene, vinylidene fluoride-hexafluoropropylene copolymer,  
4   polypropylene, polyethylene, and polysulfone.

1           17.    The fuel cell as claimed in claim 10, wherein at least one functional  
2   group selected from the group consisting of a carboxyl group, a sulfonic acid group,  
3   a phosphoric acid group, and a perchloric acid group is incorporated into the polymer  
4   membrane.

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1           18.    The fuel cell as claimed in claim 10, wherein the reinforced composite  
2   ionic conductive polymer membrane is formed by impregnating or spray-coating the  
3   porous support with a composition of the ion-exchange polymer and the reinforcing  
4   agent.

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1           19.    A direct methanol fuel cell comprising a reinforced composite ionic  
2   conductive polymer membrane, the membrane comprising:  
3       a porous support;  
4       an ion-exchange polymer that impregnates the porous support; and  
5       a reinforcing agent that impregnates the porous support, the reinforcing agent  
6   being at least one selected from the group consisting of a moisture retentive material  
7   and a catalyst for facilitating oxidation of hydrogen.

1           20.    The direct methanol fuel cell as claimed in claim 19, wherein the  
2   porous support comprises at least one polymer membrane that has a porosity of at  
3   least about 30% and a proton exchange functional group.

1           21.    The direct methanol fuel cell as claimed in claim 19, wherein the  
2 porous support comprises at least one polymer membrane selected from the group  
3 consisting of polytetrafluoroethylene, vinylidene fluoride-hexafluoropropylene  
4 copolymer, polypropylene, polyethylene, and polysulfone.

1           22.    The direct methanol fuel cell as claimed in claim 20, wherein the proton  
2 exchange functional group is at least one selected from the group consisting of a  
3 carboxyl group, a sulfonic acid group, a phosphoric acid group, and a perchloric acid  
4 group.

1           23.    A method of forming a reinforced composite ionic conductive polymer  
2 membrane, the method comprising the steps of:  
3           providing a porous support;  
4           forming a mixture of an ion-exchange polymer and a reinforcing agent, the  
5 reinforcing agent being at least one selected from the group consisting of a moisture  
6 retentive material and a catalyst for facilitating oxidation of hydrogen, and  
7           impregnating the porous support with the mixture.